DOCKET FILE COPY ORIGINAL

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	MM Docket No. 99-25
	)	
Creation of a Low Power	)	RM-9208
Radio Service	)	RM-9242
	)	
	)	

To: The Commission

RECEIVED
AUG 2 1999
FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF THE SECRETARY

COMMENTS OF THE CONSUMER ELECTRONICS MANUFACTURERS ASSOCIATION

Gary S. Klein
Vice President,
Government and Legal Affairs

Michael Petricone
Director, Technology Policy
Government and Legal Affairs

George Hanover
Staff Vice President
Technology & Standards

Ralph Justus
Director
Technology & Standards

2500 Wilson Boulevard
Arlington, Virginia 22201
(703) 907-7600

Of Counsel:

David A. Nall
Benigno E. Bartolome
Squire, Sanders & Dempsey L.L.P.
1201 Pennsylvania Avenue, N.W.
Post Office Box 407
Washington, D.C. 20044
(202) 626-6600

August 2, 1999

No. of Copies rec'd 0+4
List ABCDE

SUMMARY

In this proceeding, the Commission proposes to establish rules authorizing the operation of new, low power FM ("LPFM") radio stations. While the Consumer Electronics Manufacturers Association ("CEMA") does not oppose the creation of a low power FM radio service, it urges the Commission to remain mindful of the technical requirements necessary to protect existing FM radio services and preserving the excellent technical quality of FM radio service available today.

CEMA is particularly concerned about the consequences of LPFM for the listening public in terms of the potential for interference with current FM receivers. In order to minimize the impact for potential interference, the Commission must not only protect stations operating on the same channel or on a 1st-adjacent channel from interference caused by LPFM facilities, but it must also protect stations operating on the 2nd- and 3rd- adjacent channels.

In an effort to assist the Commission in resolving the technical issues of concern to the public, CEMA, with support of National Public Radio and the Corporation of Public Broadcasting, initiated a comprehensive examination of FM receiver interference tests, which in CEMA's view provide a sufficient basis to evaluate the potential impact of LPFM on current FM receivers. The results of these tests form the substance of CEMA's comments herein and are summarized below:

- The current co-channel protection ratio (desired-to-undesired, "D/U") of 20 dB results in an average signal-to-noise ("S/N") ratio of 24 dB. A D/U of 30 dB results in an average S/N or 34 dB, which results in marginally adequate reception quality.
- The current 1st-adjacent protection ratio of 6 dB D/U results in an average S/N of 36 dB. Tests also show that, under these conditions, base band noise had a significant effect on the 67 kHz and 92 kHz analog subcarrier performance. Further, these

conditions produce analog signals 25 dB greater than in-band/on-channel ("IBOC") Digital Audio Radio systems' 1st-adjacent digital sidebands, creating significant potential analog-to-digital interference.

- The current 2nd-adjacent protection ratio of –40 dB D/U results in an average S/N of 28 dB, while at a D/U ratio of –30 dB the average S/N ratio is 35 dB. Based on this finding, CEMA recommends that the 2nd-adjacent protection be maintained.
- The current 3rd-adjacent protection ratio of –40 dB D/U results in an average S/N of 36 dB. Based on this finding, CEMA recommends that the 3rd-adjacent protection be maintained.
- Intermodulation tests show that the current Intermediate Frequency ("IF") protection requirements are required to avoid both IF interference and local oscillator interference.

Based on these findings, and other issues discovered during the course of testing, CEMA found that extensive objectionable interference to FM reception would occur to current receivers if the LPFM service were deployed as proposed. CEMA, therefore, urges the Commission to insure that any technical rules established resolve the interference issues found in CEMA's examination of FM receiver interference tests. The Commission must not permit the degradation of FM radio service to the listening public. Additionally, the Commission must also insure that the creation of a low power FM radio service will not threaten the development and deployment of future terrestrial digital audio radio services, which as CEMA's tests reveal, face interference from 2nd-adjacent channels.

TABLE OF CONTENTS

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	MM Docket No. 99-25
	)	
Creation of a Low Power	)	RM-9208
Radio Service	)	RM-9242
	)	
	)	

To: The Commission

COMMENTS OF THE
CONSUMER ELECTRONICS MANUFACTURERS ASSOCIATION

The Consumer Electronics Manufacturers Association ("CEMA"), by its attorneys and pursuant to Section 1.415 of the Commission's Rules, 47 C.F.R. § 1.415, hereby submits its comments in response to the above-referenced Notice of Proposed Rulemaking ("*NPRM*").[1]

I. INTRODUCTION AND STATEMENT OF INTEREST

In the *NPRM*, the Commission seeks comment on its tentative proposal to establish rules authorizing the operation of new, low power FM ("LPFM") radio stations.[2] In particular, the Commission proposes to create two classes of lower power radio service, both of which would operate in the existing FM radio band: a 1000-watt primary service and a 100-watt secondary

---

1 *See In the Matter of Creation of a Low Power Radio Service*, MM Docket No. 99-25 (RM-9208; RM-9242), Notice of Proposed Rulemaking, FCC 99-6 (rel. Feb. 3, 1999) ("*NPRM*").

2 The Commission does not intend to create a low power radio service on any spectrum beyond that which is currently allocated for FM use, and the Commission does not propose to use the AM band. *Id.* at ¶ 15.

service.[3] The Commission believes that these new LPFM stations would provide a low-cost means of serving urban communities and neighborhoods, as well as populations living in smaller rural towns and communities. In the *NPRM*, the Commission is proposing that LPFM stations not be subject to certain technical rules currently applied to other classes of radio service. In particular, the Commission believes that current restrictions on third-adjacent channel operations are not needed for LPFM stations, and it further believes that it may be possible to disregard second-adjacent channel interference for these stations as well. At the same time, the Commission is proposing new technical rules and geographic spacing requirements to ensure that new LPFM stations do not cause interference to existing full service FM radio stations. The Commission states that, in adopting any rules and requirements, it "will also be wary of any provisions that would limit the development of future terrestrial digital radio services."[4] The *NPRM* also addresses related matters such as service rules, ownership issues, and application processing procedures for LPFM services.

CEMA, a sector of the Electronic Industries Alliance, is the principal trade association of the consumer electronics industry. CEMA members design, manufacture, distribute and sell a wide variety of consumer electronics equipment, including radio broadcast receivers. As such, CEMA has an interest in maintaining the integrity of current radio products and, at the same time, supporting efforts to open the electronics manufacturing industry to new product opportunities. In this regard, the Commission must insure that any new low power FM radio service will protect existing FM radio services and preserve the technical integrity of radio

---

3 The Commission also proposes to establish a third, "microradio" class of low power radio service that would operate in the range of 1 to 10 watts on a secondary basis.

4 *NPRM*, at ¶ 1.

service today which has been fostered and maintained by existing FCC rules. The Commission must also insure that the creation of a low power FM radio service will not threaten the development and deployment of terrestrial digital audio radio services.[5] These significant concerns are the focus of CEMA's comments which are discussed further below.

II. THE INTERFERENCE PROTECTION CRITERIA TENTATIVELY PROPOSED BY THE COMMISSION FOR LPFM COULD SIGNIFICANTLY HARM EXISTING AND FUTURE FM SERVICE.

The testing CEMA conducted with support of National Public Radio and the Corporation for Public Broadcasting raises significant concerns over the Commission's tentative proposal to eliminate interference protection requirements. Specifically, CEMA strongly disagrees with the Commission's tentative conclusion not to include 2nd- and 3rd- adjacent channel and Intermediate Frequency-related protection requirements for any LPFM service, because the absence of these requirements is likely to result in significant interference to current and future FM service and threaten the development and deployment of future terrestrial digital audio radio services.[6]

---

5 *See* CEMA's Comments (filed Dec. 23, 1998), in *USA Digital Radio Partners, L.P.'s Petition for Rulemaking for Amendment of Part 73 of the Commission's Rules to Permit the Introduction of Digital Audio Broadcasting in the AM and FM Broadcast Services*, RM-9395 (pending); *Public Notice*, DA 98-2244 (Nov. 6, 1998). As CEMA stated in its comments in RM93-95, CEMA fully supports efforts to implement terrestrial digital audio radio systems. CEMA believes that digital audio radio is poised to revolutionize radio in the same way that digital television is revolutionizing TV. Although radio continues to be a strong medium, it is clear from CEMA's consumer research that consumers desire improved service and enhanced radio quality.

6 Currently, each class of FM station is afforded protection from several types of harmful interference, specifically: interference from co-channel stations (*i.e.*, stations operating on the same frequency as the protected station), interference from first-adjacent channel stations (*i.e.*, stations operating on channel higher or lower in frequency than the protected station), interference from second-adjacent channel stations (*i.e.*, stations operating two channels higher or lower in frequency than the protected station), and third-adjacent channel stations (*i.e.*, stations operating three channels higher or lower in

As described in the *NPRM*, the Commission proposes two distinct classes of service: (1) a primary LPFM service class with an effective radiated power ("ERP") limit of 1,000 watts ("LP1000") and (2) a secondary class with an ERP limit of 100 watts ("LP 100"). The Commission is also considering establishing a very low power secondary "microradio" service with an ERP limit of one to ten watts. In the *NPRM*, the Commission also provides a technical overview of these services. Specifically, with respect to the issue of interference protection standards, the Commission observes the need to protect stations operating on the same channel or on a 1st- adjacent channel from interference caused by LPFM facilities, and the Commission proposes these protections for any LPFM class it would authorize.[7]

The Commission notes that commenters supporting LPFM services generally oppose any requirements for 2nd- or 3rd – adjacent channel protections, asserting that such interference from low power stations would be, at most, minimal. Despite the Commission's acknowledgment of potential interference, it nonetheless opposes interference protections because it "would limit substantially the number of channels available for low power radio generally and could preclude altogether the introduction of LPFM service in mid-sized and large cities."[8] Therefore, the Commission states, "to the extent possible, we are inclined to authorize low power service without any 2nd- and 3rd- adjacent channel protection standards."[9]

---

frequency from the protected station), and intermediate frequency ("IF") interference (*i.e.*, signals from stations offset in frequency by10.6 and 10.8 MHz from the protected station). *See NPRM*, Appendix A, at ¶ 2.

7 *NPRM*, at ¶ 42.

8 *Id.*

9 *Id.*

The Commission's tentative proposal, however, is not supported by sufficient technical data. The Commission indicates that it bases its decision to eliminate 3rd-adjacent channel protection, for example, in part due to the lack of evidence in this proceeding that lend technical support for including this restriction.[10] CEMA urges the Commission to consider FM receiver interference susceptibility tests in order to weigh the potential impact of the Commission's proposals objectively.

As further described below, CEMA undertook a comprehensive examination of interference concerns and determined, based on the technical evidence developed, that 2nd- and 3rd- adjacent channel protections should be retained to prevent interference and/or protect future terrestrial digital audio radio service.[11] A comprehensive examination of FM receiver interference confirms that the Commission's proposal could potentially cause extensive objectionable interference to existing services.

Additionally, the Commission must take into consideration the implications of 2nd-adjacent channel protection for the possible conversion of existing analog radio services to a digital mode. In the *NPRM*, the Commission expresses concern that its understanding of future in-band, on-channel ("IBOC") systems is still preliminary and admits that it "may not be fully aware of any negative impact or restriction that authorization of lower power radio service would

---

10 *Id.* at ¶ 43 (The Commission states: "no comments yet filed in this proceeding provide technical support for including this restriction.").

11 CEMA notes that the concerns expressed by the Commission in deciding not to authorize lower power radio use in the AM radio band appear to also be extant in the FM radio band. In the *NPRM*, the Commission states that it refrained from authorizing low power radio use in the AM radio band because "interference potential and present congestion in the AM band, where many stations currently experience significant interference and degraded reception, make it a poor choice for a new radio service." *Id.* at ¶ 17.

have on the transition to a digital IBOC technology for FM stations."[12] The Commission states further: "[c]learly, we need to better understand the potential impact of second-adjacent channel LPFM protection standards on the successful development of an IBOC system."[13] Thus, the Commission asks whether it would be appropriate to impose 2nd-adjacent channel protection requirement on LPFM stations for the purpose of protecting possible future digital radio technology, considering that creating opportunities for new radio service is also an important Commission goal.

CEMA's testing shows that digital audio radio service could face interference from 2nd-adjacent channels. Given this dim result, it is CEMA's view that the future development of terrestrial digital audio radio would be unduly limited by the addition of numerous new facilities operating on the FM band. Such result would appear to run counter to the Commission's express commitment to support the implementation of terrestrial digital audio radio technology, stating:

> We believe that existing radio broadcasters can and should have an opportunity to take advantage of new digital radio technologies, and we are optimistic that technical advances will, in the near future, permit both FM and AM broadcasters to offer digital sound. To this end, we are committed to continuing our work with the broadcast industry to ensure that the broadcasters are able to promptly implement terrestrial DARS.[14]

Given these serious concerns, the Commission should reconsider its tentative proposals for interference protections. It is imperative that any technical rules established must first resolve the interference issues found in CEMA's test results. The Commission must not permit the degradation of FM radio service to the listening public. In addition, the Commission must

---

12 *Id.* at ¶ 49.

13 *Id.*

14 *In the Matter of Amendment of the Commission's Rules With Regard to the Establishment and Regulation of New Digital Audio Radio Services*, GEN Docket No. 90-357, Notice of Proposed Rulemaking and Further Notice of Inquiry, 7 FCC Rcd 7776, 7780 (1992).

also insure that creation of LPFM does not threaten the development of terrestrial digital audio radio services.

III. THE RESULTS OF INTERFERENCE TESTING CEMA CONDUCTED WITH SUPPPORT OF NATIONAL PUBLIC RADIO AND THE CORPORATION FOR PUBLIC BROADCASTING RAISES SERIOUS CONCERNS OVER THE COMMISSION'S PROPOSALS TO ELIMINATE INTERFERENCE PROTECTION REQUIREMENTS.

In an effort to assist the Commission resolve technical issues raised in the *NPRM – i.e.*, 2nd adjacent, 3rd-adjacent, and intermediate frequency interference susceptibility, as well as the effects of narrow bandwidth transmissions on stereophonic reception – CEMA, with support of National Public Radio and the Corporation for Public Broadcasting, undertook a comprehensive laboratory measurement program to study the impact of different interference scenarios on FM receivers. The detailed results of these tests are attached to these comments as Exhibit A.[15] Below is a description of the testing process used and a synopsis of the results of the various FM receiver interference susceptibility tests conducted. The purpose of these laboratory tests is to evaluate the sensitivity of consumer FM receivers to interference from other FM band signals.[16]

---

15 *See* Exhibit A: "FM Receiver Interference, Tests, Laboratory Test Report," Thomas B. Keller, Robert W. McCutcheon, published by the Consumer Electronics Manufacturers Association (1999). Included in Exhibit A are the test and measurement procedures and equipment, the data on results and summary findings.

16 The tests were divided into seven sub-sets, A through G: A (laboratory calibration and receiver characterization), B (interfernce: co-channel, 1st, 2nd, and 3rd adjacent tests), C (post-detection noise), D (IF Taboo and interference), E (reduced undesired modulation), F (performance in on-air environment), G (intermodulation with 800 kHz spacing), and H (laboratory test procedures).

A. Description of Receiver Characterization

A representative sample of 16 FM receivers were selected for testing.[17] Receiver characterizations are required to gain a thorough understanding and record of each receiver's performance and operating characteristics, upon which subsequent interference susceptibility test results can be weighed. Characterization tests measured each receiver's local oscillator frequency, standard audio output level, input overload point, AM rejection, image rejection, signal-to-noise (S/N) versus radiofrequency (RF) level curves, capture ratio, selectivity for 1st, 2nd, and 3rd-adjacent signals, 10.7 MHz intermediate frequency rejection, 10.7 MHz intermodulation and 10.7 MHz local oscillator interference. The results for each receiver appear under "Appendix RECEIVER" (Tab R) in Exhibit A of these comments.

B. List of Sample Test Receivers

The sample test receivers are listed in Exhibit A, Test A. These correspond to the types shown below.

Test FM Receivers	Type
1 Delco	Car tapedeck/radio **OEM**
5 Ford	Car tapedeck/radio **OEM**
7 Audiovox	Car tapedeck/radio
13 Koss	Car tapedeck/radio
15 Ford	Car tapedeck/radio **OEM**
3 Panasonic	Stereo tap/radio boombox
9 Sony Walkman	Headset radio/tape player
11 Sanyo TR	Receivers in a compact home system
12 Sony TR	Stereo CD/radio boombox
14 Magnavox	Receivers in a compact home system
16 Radio Shack	Stereo CD/radio boombox

[17] Their performance were fully characterized using the procedures specified in ANSI/IEEE Standard 185 (1975) (referred to in Exhibit A as IEEE IHF-T-200 1975), "Standard Methods of Testing Frequency Modulation Broadcast Receivers," and IEC 315-1, "Methods of Measurement on Radio Receivers for Various Classes of Emission." These are the recognized test and measurement procedures.

2 Denon 380	Home tuners
4 Pioneer	Home receiver
6 Denon 680	Home tuner
8 Sony HiFi	Home receiver
10 Technics HiFi	Home receiver

C. FM Receiver Market Penetration and Listening Statistics

The test receiver sample and their corresponding interference performance can be weighed with the following receiver penetration information. As illustrated below, CEMA's market research, conducted in 1998, reveals the following FM receiver sales in the United States by type. The total FM receivers in use in the United States totals 710 million.

	1998	
Table radio	871,177	1% Of total
Clock radio w/out CD	10,835,015	16% Of total
Clock radio w/cd	633,350	1% Of total
All portable radio	6,394,727	10% Of total
Headset radio/tape PLAYER	11,257,499	17% Of total
Headset radio/tape Recorder	151,402	0% Of total
Mono tape/radio boombox	272,765	0% Of total
Stereo tape/radio boombox	2,335,797	4% Of total
Stereo CD/radio boombox	12,941,978	19% Of total
Home receivers	1,986,639	3% Of total
Home tuners	21,703	0% Of total
Receivers in a compact home system	8,946,490	13% Of total
Receivers in a rack home system	367,346	1% Of total
Car tapedeck/radio	5,201,536	8% Of total
Car CD/radio	4,234,725	6% Of total
	66,452,149	100%

1997 FACTORY-INSTALLED AUTOSOUND

	Total Auto Units	Percent w/audio
US Car Sales:	8,272,043	97.8
US Light Truck & MPV	6,849,647	97.4 (*)
Import Cars	1,335,258	93.6
Import Light Trucks & MPV	507,864	87.1

(*) – US Light Truck & MPV show 25,954 units with "AM-only" so this percentage needs a slight downward adjustment to accurately reflect FM receivers.
Source: Wards Communications, Inc.
Compiled by CEMA in "OEM Mobile Electronics Market Trends Guide" 1998

The 82.9 million home, personal and auto aftermarket and OEM FM receivers sold annually, thus break out into the following percentages by category:

Table	15%
Personal	22%
Portable	19%
Component	14%
Auto	31%

This information is significant because these category types generally have similar circuitry designs and corresponding interference susceptibility performance. Also, Radar and Arbitron data show that radio listening occurs in various environments: home 37.2%, work 21.2%, and car 41.6%. Of that percentage for work listening, 12% is in the car. Consequently, the following receiver types are used in daily radio listening: 55.2% home receivers, 44.1% car receivers. These listening statistics can be further applied to the receiver test results. We can further assume that the entire population of in-use receivers corresponds roughly to the annual sales categories.

D. Test Results

Throughout the testing, a target audio signal-to-noise (S/N) ratio (weighted, quasi-peak) of 45 dB was used as a reference since this was previously established as a minimum for quality

broadcasting.[18] The particular test results are presented with various combinations of S/N and desired-to-undesired (D/U) protection ratios.

1. Co-channel interference

The current co-channel protection ratio (D/U) of 20 dB was found to produce a S/N averaged over the test receiver sample of 24 dB, which in CEMA's view constitutes unacceptable reception quality. Examining performance to attain the target 45 dB S/N shows that this requires an average D/U protection ratio of 42 dB. Consequently, a significant increase in interference to existing services will be experienced with the addition of new LPFM stations, even respecting the 20 dB D/U protection ratio.

2. First-adjacent channel interference

The current 1st-adjacent channel protection ratio of 6 dB (D/U) was found to produce an average S/N of 35 dB. However, a target 45 dB S/N was only achieved with an average D/U of 17 dB (although a large, 32 dB, spread in receiver performance was observed, with auto receivers exhibiting among the best performance).[19] The test revealed that post-detection noise causes an increase in receiver baseband noise with first-adjacent channel interference when the desired channel is modulated. This affects the 38 kHz stereo difference signal as well as 67 kHz and 92 kHz subcarriers, with the higher frequency subcarriers suffering the greatest degradation.[20] Past studies examined in-band/on-channel (IBOC) Digital Audio Radio (DAR)

---

18 *See* "DTV Channel 6 Interference to FM Band Reception – Final Report," July 24, 1998, filed by National Public Radio as an *ex parte* submission on October 20, 1998, in MM Docket 87-268.

19 *See* Exhibit A, Test B.2, Chart #4 (observing the performance for receivers 1, 5, 7 and 13).

20 *See* Exhibit A, Test C.

system performance, particularly with respect to analog-to-digital interference.[21] IBOC DAR designs generally place the digital energy in the 1st-adjacent channel spectrum (referenced to the "host" analog signal carrier frequency). Consequently, the analog 1st-adjacent protection ratio of 6 dB results in analog (undesired) energy approximately 19 dB higher than, and on frequency to, one of the desired digital IBOC sideband signals. Past studies of both IBOC DAR and DTV systems have shown an approximate co-channel protection ratio of 10 dB D/U (analog-to-digital interference) is required. Consequently, if protection of IBOC DAR systems is to be considered, a 1st-adjacent FM-to-FM protection ratio of 35 dB (D/U) is needed. It is difficult to find existing full-service FM spectrum meeting that protection requirement, and LPFM would clearly exacerbate that situation. For this reason, CEMA believes that LPFM and IBOC DAR systems are mutually exclusive.

3. Second-adjacent channel interference

The current 2nd-adjacent protection ratio of –40 dB (D/U) is found to produce an average S/N of 28 dB, with four of the receivers in the test sample exhibiting a S/N below 10 dB which is considered a complete loss of channel usability.[22] To achieve the target S/N of 45 dB, a D/U protection ratio of –20 was required. Here again, the car receivers generally exhibited better performance. If IBOC DAR is considered, a 2nd-adjacent FM situation places IBOC DAR digital sidebands in immediate adjacency or in an overlap situation (depending on IBOC design). Past

---

21 *See* "Technical Evaluations of Digital Audio Radio Systems: Laboratory and Field Test Results; System Performance; Conclusions," Final Report (Dec. 1997), a copy of which was submitted *ex parte* on July 13, 1999, in this docket in order to afford interested parties an opportunity to review and comment on the information provided therein. A copy of this study was also submitted as Appendix A to CEMA's Comments (filed Dec. 23, 1998) in RM-9395 (USA Digital Radio Partners, L.P.'s Petition for Rulemaking).

22 *See* Exhibit A, Test B, Chart #9.

studies have revealed these conditions require a digital-to-digital protection ratio also in the range of –20 dB. Accordingly, the Commission should reconsider its tentative proposal to eliminate 2nd-adjacent interference protection requirements, because it could result in creation of extensive new, objectionable interference to existing services. Further, these results suggest that the current protection ratio of –40 dB is insufficient to maintain a high-quality primary service. CEMA recommends the Commission reconsider this matter and consider establishing a –20 dB protection requirement.

4. Third-adjacent channel interference

The current protection ratio of –40 dB D/U produces and average S/N of 34 dB. With a D/U of –30 dB, however, the average S/N of 42 dB (nearer to the target S/N) was achieved. Charts 11-13 of Test B.4 in the attached Exhibit show decreasing audio S/N as the undesired signal increases from a D/U of –30 dB, -40 dB and –50 dB. At –50 dB D/U, the average S/N was 27 dB. This further indicates that S/N levels below 10 dB in some receivers represent a complete loss of channel usability – in some cases the receiver stopped working (no-audio) altogether.

Based on these results, CEMA believes that the Commission's proposal to eliminate 3rd-adjacent protection requirements for LPFM would result in creation of extensive new objectionable interference to existing services. Accordingly, CEMA urges the Commission to reconsider its tentative proposal on this matter and establish, instead, a -30 dB protection requirement.

5. Subjective assessments of 2nd- and 3rd-adjacent channel interference

During the testing of 2nd-and 3rd-adjacent interference, and reduced deviation studies, digital audio recordings were made representing various combinations of protection ratios,

resulting S/N performance in certain receivers, and impact of program audio material on subjective perceptibility of the resulting impairments. These are undergoing formal subjective evaluations and CEMA will present the results of this testing to the Commission shortly.[23]

6. Intermediate frequency "taboo" and local oscillator interference

The Commission has proposed eliminating the Intermediate Frequency ("IF") protection requirement for LPFM. The IF "taboo" protects stations from intermodulation interference caused by two stronger stations operating in the same service area with a frequency separation of 10.6 MHz or 10.8 MHz (while the FM receiver IF frequency is 10.7 MHz). This interference is receiver dependent and will be heard on most FM signals throughout the band that are lower in RF level than the two undesired stations separated by 10.6 MHz or 10.8 MHz in frequency.

Appendix D of Exhibit A presents test results of receiver susceptibility to IF interference at two desired signal levels, -45 dBm and –60 dBm, using receivers that were found sensitive to IF intermodulation interference during the receiver characterization tests – primarily home hi-fi units. The results are presented in terms of target S/N and resulting D/U ratios. For example, at a desired level of –45 dBm, a target S/N level of 40 dB was achieved with an average protection ratio of –12 dB D/U.

Local oscillator interference is caused by a single station operating at 10.6 MHz or 10.8 MHz above the desired signal and affects reception of those two stations. The tests show that a 0 dB D/U protection ratio must be maintained to achieve a 40 dB S/N ratio.

Both these tests show that this type of interference has been largely controlled by adherence to the existing IF taboo protection requirements. Should the Commission eliminate

---

23 CEMA notes that National Public Radio is including in its comments in this proceeding CDs containing the full set of subjective, which is described in Appendices B and E of Exhibit A.

this protection, as proposed for LPFM, the resulting objectionable interference would be severe, though localized; IF intermodulation, however, would affect reception throughout the FM band. CEMA therefore recommends that the Commission maintain the current IF taboo protection requirements for LPFM.

7. Reduced undesired modulation

The *NPRM* solicits information about performance with reduced FM modulation and its impact on interference. Appendix E in the attached Exhibit describes restricted modulation scenarios (with various bandwidth and FM deviation limitations) used for testing and the results on quality of reception and 2nd- and 3rd-adjacent channel interference.

For 2nd-adjacent channel interference, the –20 dB D/U tests show that the desired audio noise level was reduced (improved S/N performance) by from 4 dB to 13 dB with the use of reduced deviation. It should be noted that the rate of improvement is receiver dependent and has a performance tradeoff of a reduction in audio level. The 3rd-adjacent interference tests showed almost no improvement.

8. Performance in an on-air environment

Test F in Exhibit A describes a comparison of receiver performance in a multi-station on-air environment with the laboratory test performance. Local signals were received with omni-directional and directional outdoor antennas and the S/N performance of the test receivers was observed. The results show degradation in S/N when receivers are placed in an on-air environment with multiple FM signals.

9. Intermodulation with 800 kHz Channel Spacing

The mixing of two or more undesired signals in a non-linear portion of an FM receiver will generate spurious responses (intermodulation). Intermodulation interference results when

three evenly spaced signals are received and the desired signal is lower in level than the two undesired signals. This manifests itself as a constant audible hiss and can be caused by the introduction of a station that is many channels away from the desired station.

Test G in Exhibit A presents the test results using three signals spaced 800 kHz (four channels) apart and examining the S/N impact and D/U ratios. There, CEMA observes a marked decrease in S/N performance. Under the –20 dB D/U conditions, the degradation was 20-30 dB, with nine receivers showing S/N levels below 20 dB (very poor performance).

CEMA brings this to the Commission's attention since 4th-adjacent restrictions do not exist in the Commission's Rules, but yet have a markedly, and consistent, adverse impact on receiver performance. The majority of FM receivers are sensitive to RF intermodulation interference. CEMA believes this is an important finding and documents an overall degradation of received signal quality as (permissible) spectrum congestion increases.

Avoiding this interference would require creation of a new rule that would prevent a situation where the signal level of any one of three evenly spaced stations is more than 15 dB below either of the other two stations in the desired station's protected coverage area. It appears that the Commission's proposals for deploying LPFM stations, and the subsequent increase in spectrum congestion, could have the unintended effect of exacerbating this unadvisable situation.

IV. THE TEST RECIVER SAMPLE USED IN CEMA'S LABORATORY TESTING IS REPRESENTATIVE OF IN-USE RECEIVER DESIGNS.

In the *NPRM*, the Commission invites comment on the "extent to which circumstances have changed in such a way to support relaxation of [interference] protections," and comment on

the state of receiver technology and the ability of receivers to operate satisfactorily with relaxed interference protection.[24]

Receivers are designed with intentional design and cost tradeoffs that are made by manufacturers to meet market needs. For example, many high-end component Hi Fi receivers optimize their sensitivity to receive weak signals and produce high-quality sound reproduction. This performance, however, comes at the expense of lower adjacent-channel, intermodulation and IF interference rejection. Conversely, automobile receivers are designed to optimize mobile reception by greater selectivity to improve their immunity to adjacent-channel and other interference, but at the expense of their ability to receive weak signals. Rarely does one find a receiver that optimizes all these features simultaneously since such receivers will appeal to a small minority of owners.

CEMA believes that the test receiver sample used in its laboratory testing are representative of in-use receiver designs. While the test results described above largely have been presented in terms of "average" performance (across all test receivers), individual receiver results can be extracted from the data and conclusions arrived at with, for example, weighting by category/type of receiver and listening factors, cross-referenced with their underlying performance data. CEMA, however, has not done so in these comments because, in its opinion, the data as set forth in Exhibit A provides sufficient and comprehensive information that depicts the extensive objectionable interference that would be caused to existing FM services by LPFM. These data are representative of the performance of the 710 million receivers in use in the United States.

---

[24] *NPRM*, at ¶ 46 & n.65.

IV. CONCLUSION

CEMA does not oppose the creation of a new low power FM service. However, as described above, CEMA's laboratory tests have identified situations where, rather than relaxing interference protection standards, greater interference protection measures are needed to ensure and maintain quality FM reception. For these and other reasons set forth in these comments, CEMA urges the Commission to insure that any new low power FM radio service will protect existing FM radio services and preserve the technical integrity of radio service today. CEMA also urges the Commission to insure that the creation of LPFM does not threaten the development and deployment of terrestrial digital audio radio services.

Respectfully submitted,

CONSUMER ELECTONICS MANUFACTURERS ASSOCIATION

By: G. Klein / BEB

Gary S. Klein
Vice President,
Government and Legal Affairs

M. Petricone / BEB

Michael Petricone
Director, Technology Policy
Government and Legal Affairs

George Hanover
Staff Vice President
Technology & Standards

Ralph Justus
Director, Engineering
Technology & Standards

2500 Wilson Boulevard
Arlington, Virginia 22201
(703) 907-7600

Of Counsel:

David A. Nall
Benigno E. Bartolome
Squire, Sanders & Dempsey L.L.P.
1201 Pennsylvania Avenue, N.W.
Post Office Box 407
Washington, D.C. 20044
(202) 626-6600

August 2, 1999

FM Receiver Interference Tests

Laboratory Test Report

Test were Conducted under the Auspices of:

National Public Radio
Consumer Electronics Manufacturers Association
Corporation for Public Broadcasting

Published by:
Consumer Electronic Manufacturers Association

Test Laboratory:
RMC Technologies
North Olmsted, Ohio

Thomas B. Keller, Consultant
Robert W. McCutcheon, Test Manager

CONSUMER ELECTRONICS MANUFACTURERS ASSOCIATION
A sector of the
ELECTRONIC INDUSTRIES ALLIANCE
©1999 ALL RIGHTS RESERVED

FM Receiver Laboratory Test Report

July 27, 1999

Table of Contents

Attachment A

DOCUMENT OFF-LINE

This page has been substituted for one of the following:

o An oversize page or document (such as a map) which was too large to be scanned into the ECFS system.

o Microfilm, microform, certain photographs or videotape.

o Other materials which, for one reason or another, could not be scanned into the ECFS system.

The actual document, page(s) or materials may be reviewed by contacting an Information Technician. Please note the applicable docket or rulemaking number, document type and any other relevant information about the document in order to ensure speedy retrieval by the Information Technician.

LABORATORY Test Report